

Predicting Zoonotic Hemorrhagic Fever Events in Sub-Saharan Africa using NASA Earth Science Data for DoD - Global Emerging Infections Surveillance and Response System

PI & Co-I's:

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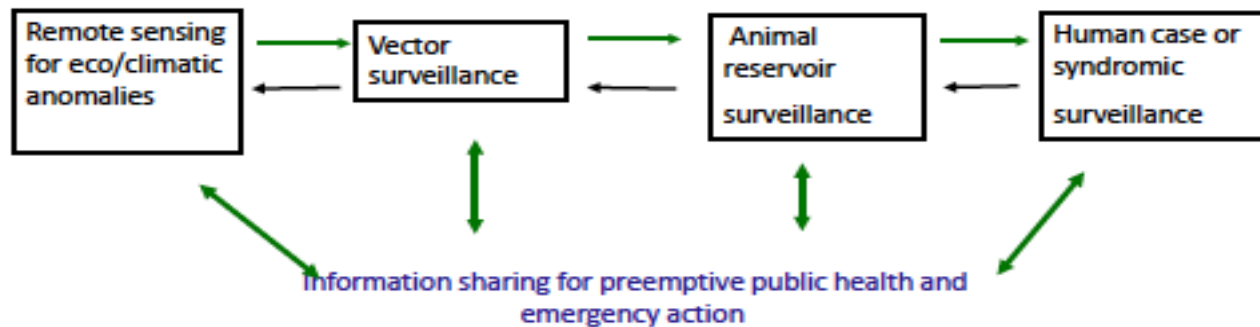
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Goals

Zoonotic Hemorrhagic Fever Events in Sub-Saharan Africa

- Enhance and strengthen DoD-GEIS efforts to build a sustainable global capacity for surveillance and response to emerging zoonoses.



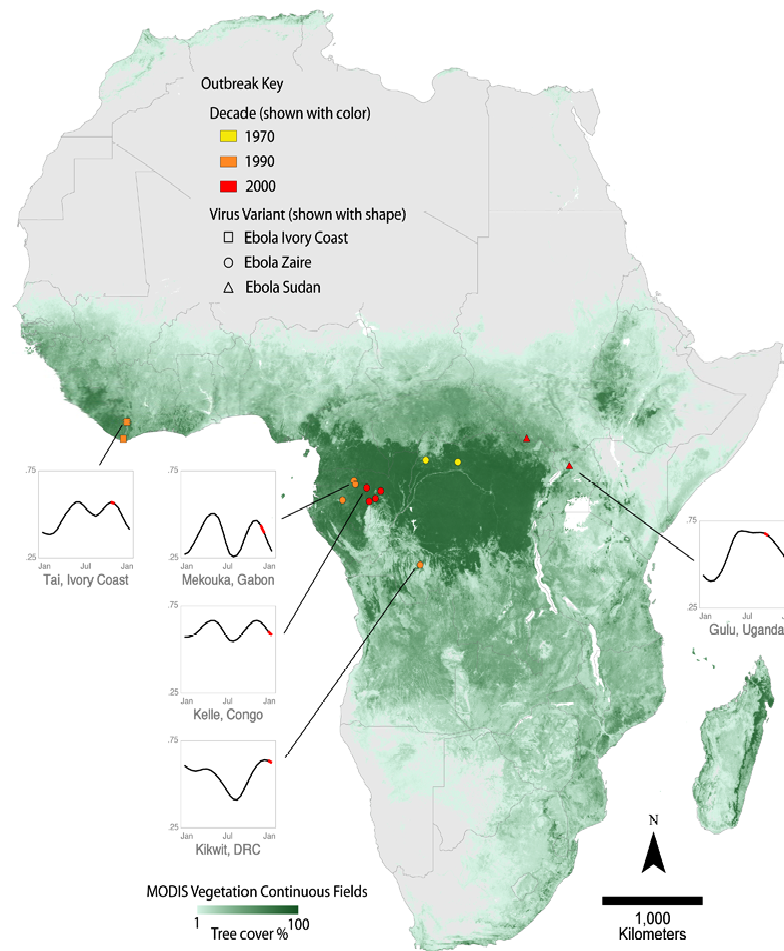
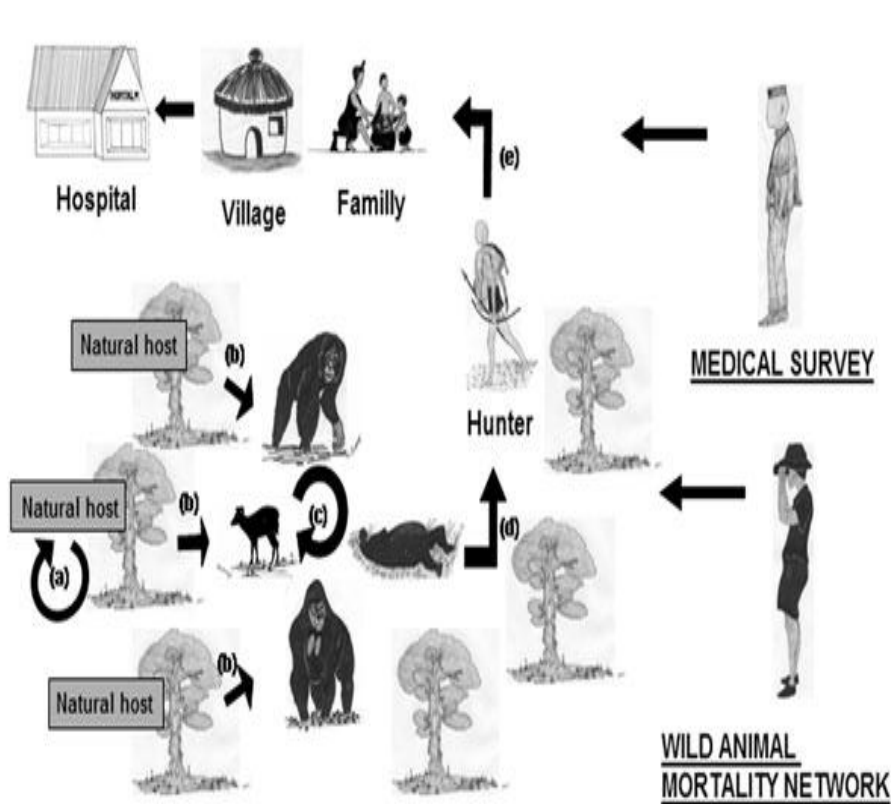
- Contribute to the development and interoperability of more international surveillance networking, complementing existing international (WHO, FAO) and national surveillance systems with early warning capabilities developed from integrated NASA Earth science data and models.
- Refine the early warning models for Rift Valley Fever (RVF), and Marburg/Ebola Hemorrhagic Fever (MHF/EHF) filoviruses with multi-level monthly risk maps.
- Prototype the development and production of a climate quality data record (NDVI-rainfall) to ensure data continuity in DoD-GEIS early warning system.



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Background – Ebola/Marburg



Ebola Cycle: Rouquet et al. EID 2005

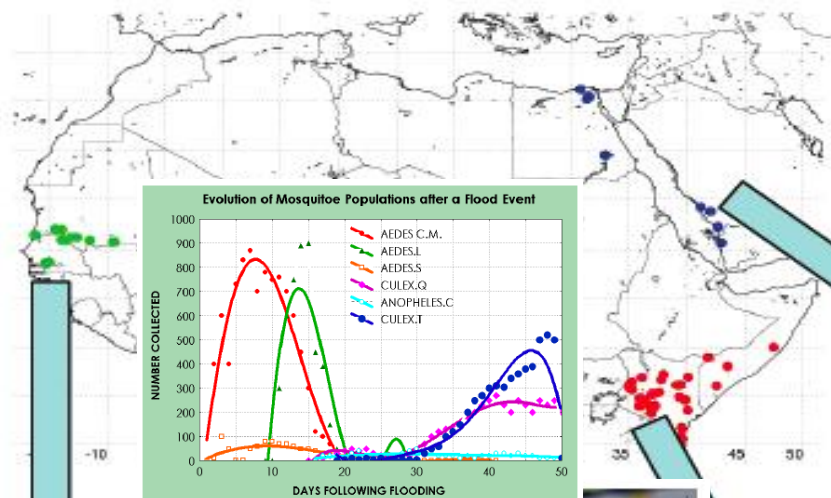


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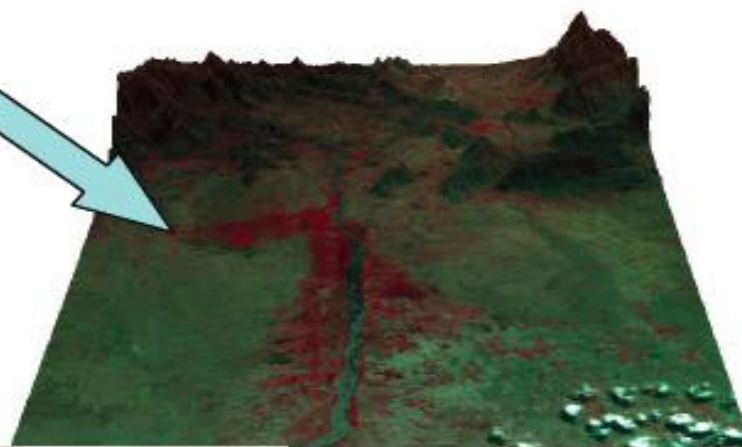


Background - RVF

Geographic Distribution of Recent Rift Valley Fever Outbreaks



Coastal Flood Plain



Riverine Flood Plain



Savanna Grassland

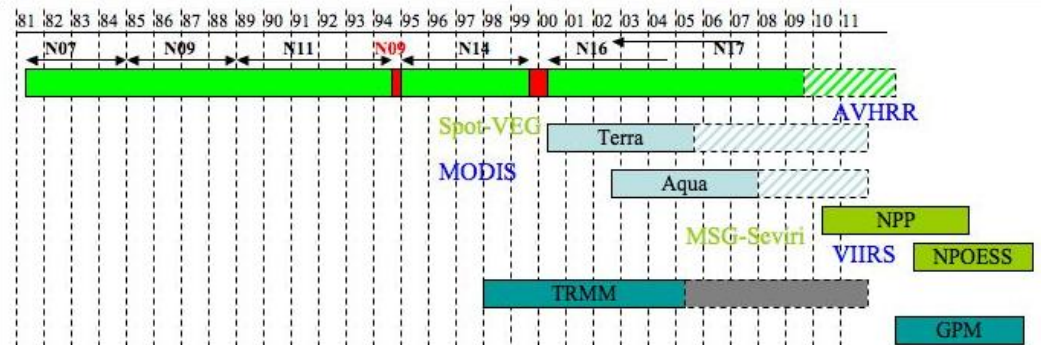
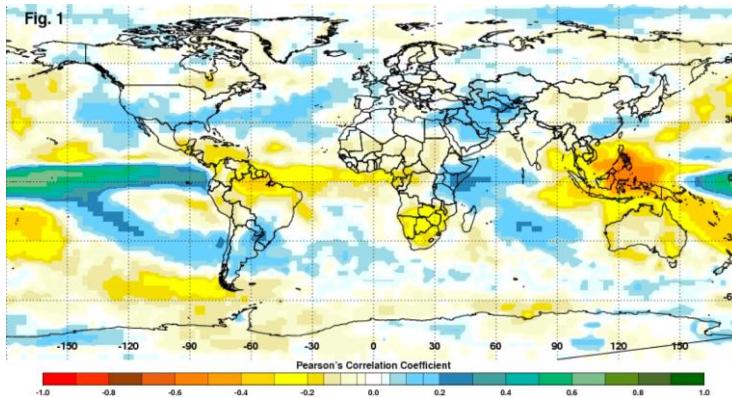


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Model Inputs

Correlation ENSO & Ecological Dynamics



Inputs

Current Sensor/Data

Operating intermediate data

Extended long-term monitoring

Climate time series

El Niño-Southern Oscillation(ENSO)
North-Atlantic Oscillation (NAO)

Disease&Vector Data

Imagery time series

Precipitation (PPTN)
Normalized Difference
Vegetation Index (NDVI)
NDVI / Temperature

Sea Surface Temperature (SST)
From NOAA(monthly update)

Latitude&Longitude&Date

TRMM - monthly update
AVHRR - biweekly or as
needed
MODIS - monthly

N/A

MeteoSat

SPOT
MODIS

GPM / Jul 2013

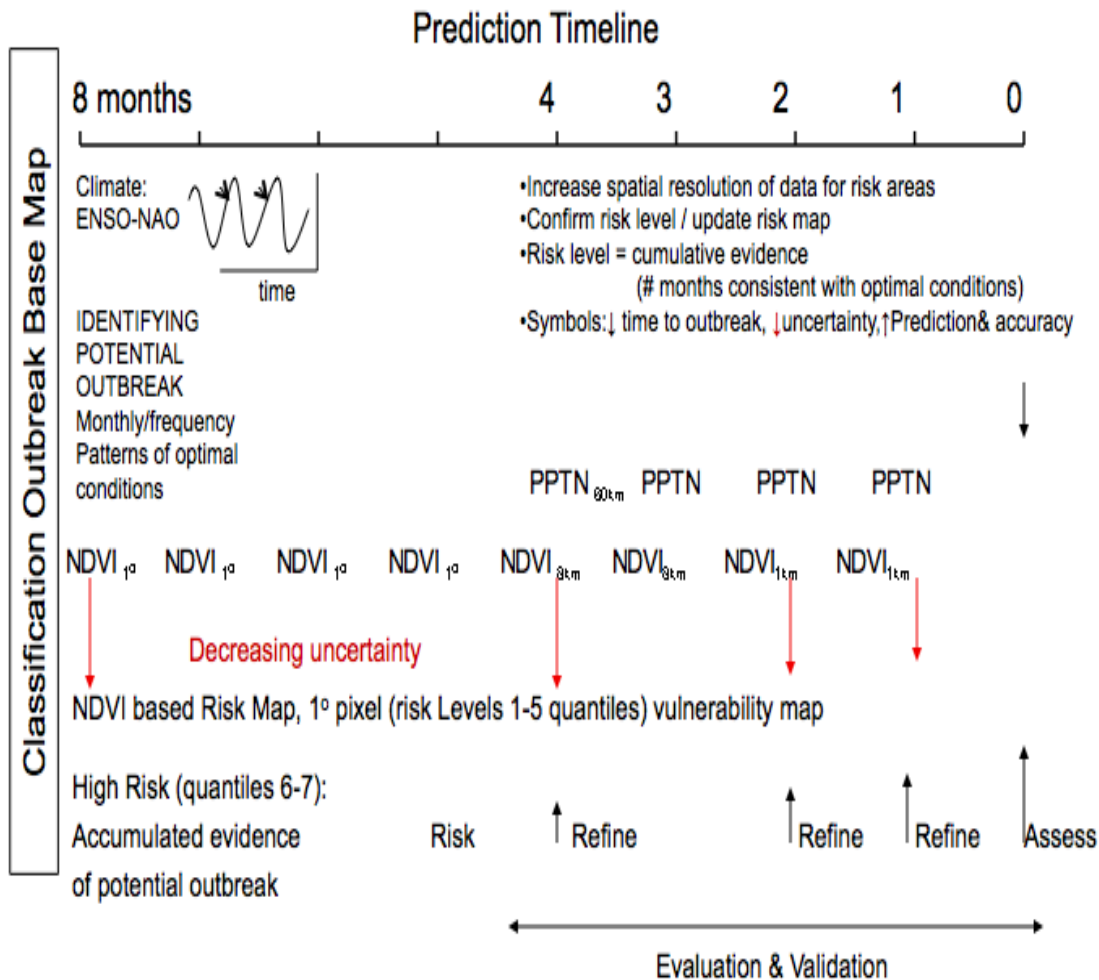
NPP-VIIRS
Jun 2011



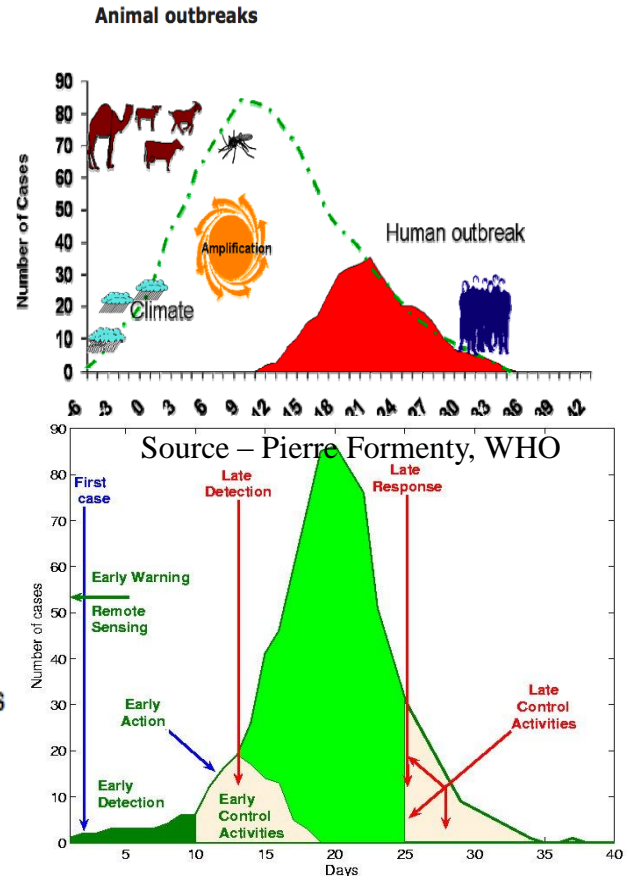
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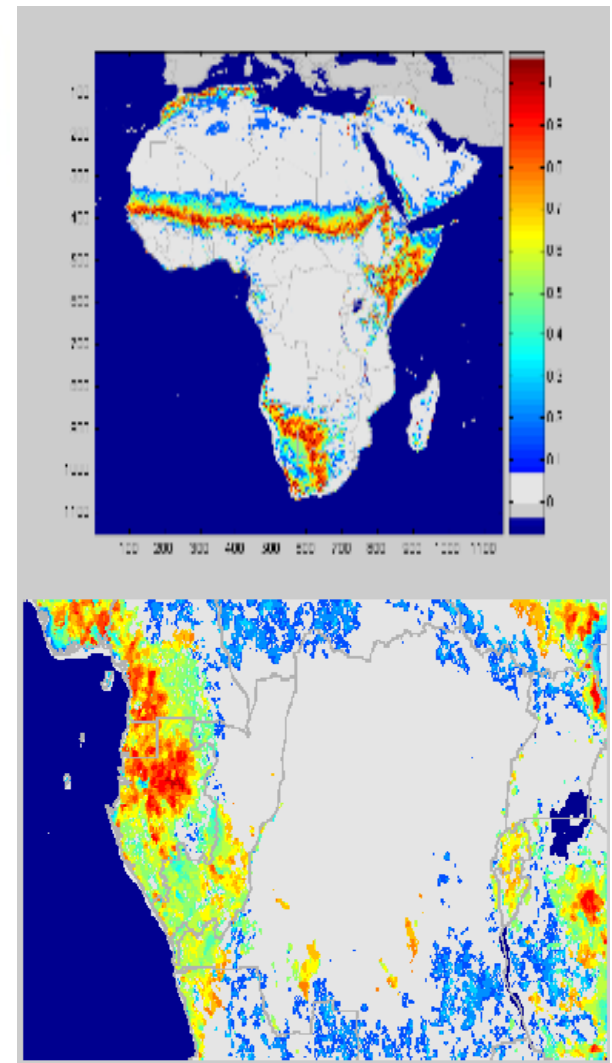
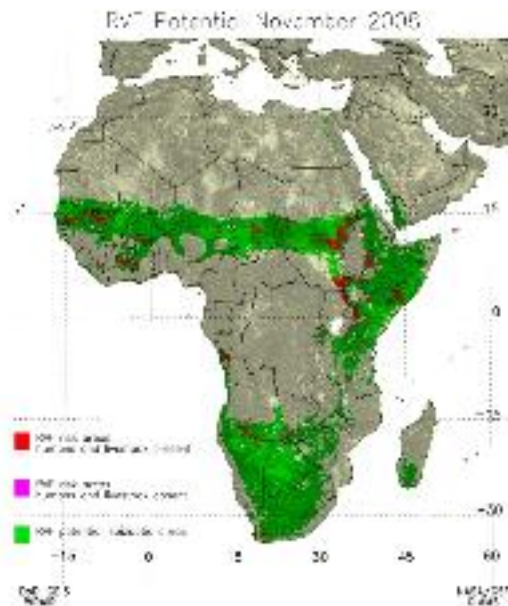
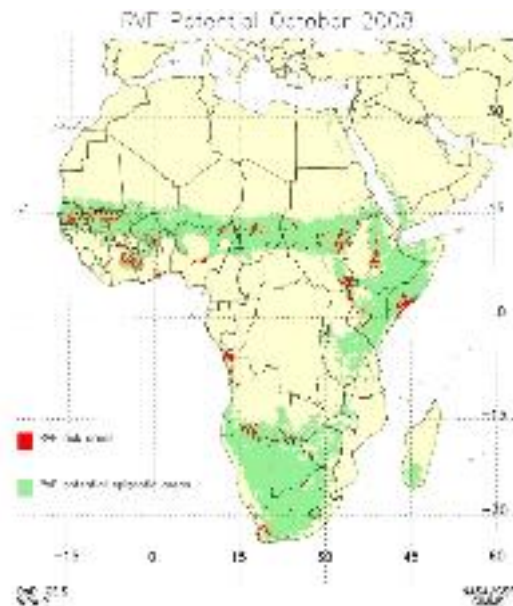
Prediction Framework



Generation of a Human Outbreak



Endemic regions: RVF & Ebola



UMBC


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DoD-GEIS Web page



DoD - GEISWeb
Global Emerging Infections System

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Climate and Disease Connections: Rift Valley Fever Monitor

[RVF Home](#) | [Background](#) | [Environment](#) | [Transmission](#) | [Climate](#) | [Monthly Updates](#) | [References](#)

Locations

- USAFSAM
- Egypt
- Indonesia
- Kenya
- NHRC
- Peru
- Thailand

Programs

- Antimicrobial Resistance
- DoD Laboratory Services
- West Nile Virus
- Gonococcal Surveillance
- Influenza
- Malaria
- Mortality
- Respiratory Disease
- Rift Valley Fever

Meningococcal Disease Surveillance

IOM Review

Monitoring and predicting disease outbreaks early enough to prevent them or reduce their impact on society is a major goal of the DoD's Global Emerging Infections System. A collaborative project between DoD-GEIS and NASA's Goddard Space Flight Center accomplishes that goal, for at least for one disease: Rift valley fever. Using near-real-time satellite vegetation measurements and associated climate data sets including sea surface temperatures and satellite derived cloudiness indices predictions about emerging Rift Valley Fever epidemics in East Africa can be made several months before an outbreak occurs. Primarily a disease of sheep, cattle and other animals, RVF can be transmitted to humans by *Aedes* and *Culex* sp. mosquitoes. Outbreaks can be devastating to the farming economies of rural East Africa and can cause significant human morbidity and mortality. Outbreaks of RVF are now well known to be coupled with above normal rainfall in East Africa associated with warm SST warming events in the Western Equatorial Indian Ocean and El Niño events in the Pacific. Monitoring the state of sea surface temperatures, rainfall and ecological conditions guides the efforts in identifying areas of potential RVF outbreaks. The ability to map such areas of potential RVF activity 2 to 5 months before outbreaks occur could permit vaccination of domestic animals and implementation of appropriate mosquito control programs.

DoD-GEIS & NASA/GSFC are now making current satellite and climate data, as well maps of on areas at risk to RVF outbreaks available on this web site. This is a part of a continuing effort in disease monitoring and surveillance. Although the information contained in this report has significant potential implications for disease prevention and control, we do not suggest that this information is absolute with regard to actual disease occurrence nor can it be used as the only basis for public policy on this disease. Rather, it is intended as a vehicle for identifying areas where field surveillance and validation of can be carried out. Persons with information that can help corroborate or refine the information contained in these pages are urged to contact us at the address indicated below. In addition, all constructive comments related to the presentation of these materials are welcome. Given this intent, persons who use this information do so at their own risk. Neither the DoD-GEIS nor NASA/GSFC take any responsibility for the consequences of any actions based on this information. All users are therefore cautioned to treat this information in the manner intended -- as a statement of research in progress for the purpose of scientific validation and review.

Updates will be posted to the DoD-GEIS web site on a regular basis.

Rift Valley Fever (RVF): Monthly Updates

[RVF Home](#) | [Background](#) | [Environment](#) | [Transmission](#) | [Climate](#) | [Monthly Updates](#) | [References](#)

2009

January	July
February	August
March	September
April	October
May	November
June	December

2008

January	July
February	August
March	September
April	October
May	November
June	December

2007

January	July
February	August
March	September
April	October
May	November
June	December

2006

<http://www.geis.fhp.osd.mil/>



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Monthly Updates

<http://www.geis.fhp.osd.mil/GEIS/SurveillanceActivities/RVFWeb/monthlypages/0908.htm>

r (RVF): Monthly Updates

[d | Environment | Transmission | Climate | Monthly Update](#)

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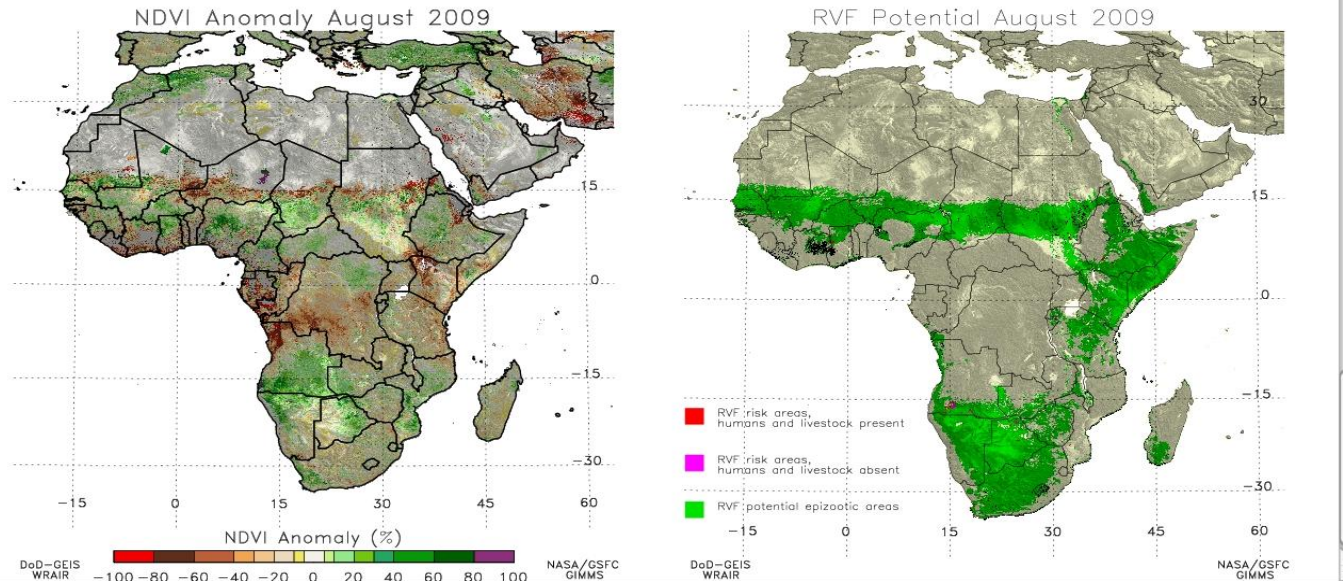
2007

January	July
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2006

January	July
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March	September

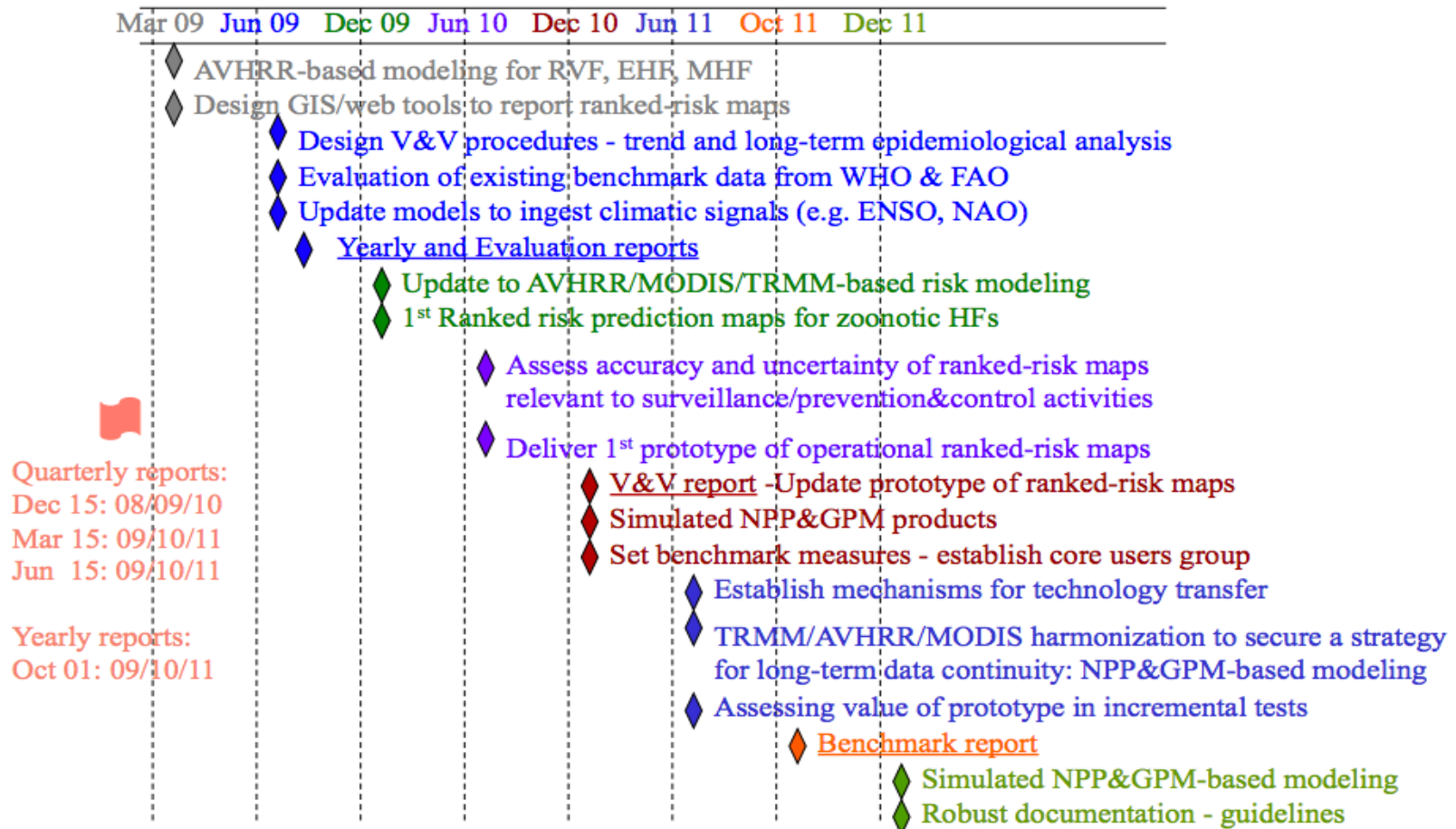
NDVI anomalies for August 2009 show below normal NDVI eastern Sahel zone into East Africa and above normal NDVI over western Sahel zone and equatorial west Africa, in areas that have received above normal rainfall over the last 3 months. The RVF risk map below was derived from thresholding NDVI anomaly data. As previously shown by research, periods of widespread and prolonged heavy rainfall precede RVF outbreaks in endemic areas (Linthicum, 1983). Since vegetation as shown by NDVI time series positively responds to such rainfall events (Justice et al, 1986), especially in semiarid areas, we can use NDVI data as a measure of the magnitude and persistence of the anomalies associated with widespread and prolonged rainfall events. In the case shown below, for the period June to August 2009, we used the following steps to derive the RVF risk map. Compute the monthly NDVI anomalies (Month - Long-term Mean), for example shown for August 2009 below. Compute the average NDVI anomaly for the three months. Identify all pixels in the three month average anomaly image that exceed +0.1 NDVI anomaly threshold and also have positive anomalies in all three months. The derived map is a measure of the persistence of positive NDVI anomalies. Overall, for the period between June to August 2009 there were no areas that showed elevated RVF activity. On the below map, areas shown in green are those within the RVF endemic region (areas where RVF virus has been identified in the past). Areas shown in red, however, indicate areas at risk for RVF activity which coincide with locations having sufficient livestock and human presence to support an outbreak. The pink shows areas theoretically at risk for RVF activity but not having sufficient livestock and human presence to support an outbreak. Given the development of El Nino conditions and warmer than normal SSTs in the equatorial Indian Ocean, there is a high likelihood of above normal rainfall in the RVF endemic areas of East Africa between September and December 2009. Therefore the undertaking of preparedness and response measures should be considered undertaken in anticipation of a greater RVF outbreak risk. In addition the above normal rainfall in some areas of West Africa (Senegal and Mauritania) in the last two months requires enhanced surveillance in areas where RVF activity has occurred before.



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Zoonotic HFVs milestones



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- USDA Foreign Agricultural Service (FAS), Washington D.C.

Field Surveillance & Data Support

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- Rosemary Sang & KEMRI Field Team
- Robert Breiman, Allan Hightower CDC Team –Kenya
- Pierre Formenty, WHO
- Stephan De La Rocque, FAO
- Bob Swanepoel, NCID, South Africa

Thank you!

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